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# ANALYSIS OF URBAN TERRAIN DATA FOR USE IN THE DEVELOPMENT OF AN URBAN CAMOUFLAGE PATTERN

BY

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Spectrophotometric data were obtained on 15 urban scenes, using Natick's Terrain Analysis System, for use in the development of an urban camouflage pattern. The data were classified into one of two categories: Type I scenes were of rubble piles; Type II scenes were of building walls. The elements of the scenes were found to vary over almost the entire lightness gamut, but concentrated in the red, orange, yellow and neutral regions of color space.

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## PREFACE

The data for this report were collected by investigators from the U.S. Army Natick Research, Development and Engineering Center from June through September 1987. This report describes urban scene colorimetric data obtained with the Natick Terrain Analysis System for use in the development of an urban camouflage pattern. These were evaluated by the Individual Protection Directorate (IPD), Natick under project No. 1L162786AH98AB029.

## ACKNOWLEDGMENTS

The author would like to thank Louis J. Dittami and Elizabeth S. McCoy of the U.S. Army Natick Research, Development and Engineering Center for their assistance in collecting the terrain data for this study. This study would not have been possible without Mr. Dittami's experience in the operation of the Terrain Analysis System and his helpful comments during the writing of this report.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

ANALYSIS OF URBAN TERRAIN DATA FOR USE IN THE DEVELOPMENT OF AN URBAN CAMOUFLAGE PATTERN

## Introduction

Natick's Terrain Analysis System (TAS) was developed to satisfy the need for a scientific method to objectively design camouflage patterns and colorations, based on actual terrain reflectance data. The TAS is capable of obtaining spectrophotometric data on a given scene, and processing the data down to the most predominant colors in the scene. This data can then be used to determine the appropriate colors and pattern for camouflage use in that terrain. Data can be obtained in the visible and near-infrared regions of the electromagnetic spectrum. The development of urban camouflage is the first such effort to utilize the capabilities of the TAS.

The character of urban terrain varies greatly, even within a city or town[1,2]. The terrain is largely man-made and is multidimensional in structure and color. During Military Operations in Urbanized Terrain (MOUT), many structures are partially or totally demolished. The resulting terrain becomes even more complex with this accumulating rubble, and standard camouflage patterns are not as effective.

The TAS has been used to obtain data on various urban scenes, in order to provide improved camouflage protection for the individual soldier in urban areas. This report documents the scenes filmed and the data obtained in this study.

## Procedure

Data was obtained by the TAS using the established data collection techniques[3,4]. Table 1 lists the scenes filmed and a short description of each one. Both rubble piles and building walls were included in the data collection. Scenes of rubble piles are designated as Type I, and scenes of building walls are Type II.

## Results

Each scene was subjected to a clustering procedure which groups picture

Table 1. Summary of Scenes Filmed for Urban Camouflage Study

| Scene # | Location | Description | Type |
|---|---|---|---|
| 705 | Natick, MA | Rubble Pile | I |
| 760 | Framingham, MA | Bancroft Building - Greyish brown stucco | II |
| 765 | Framingham, MA | Bancroft Building - Cinder blocks | II |
| 780 | Ft. Benning, GA | MOUT Village - Building | II |
| 785 | Ft. Benning, GA | MOUT Village - Building | II |
| 790 | Ft. Benning, GA | MOUT Village - Building - Painted cinder block wall | II |
| 795 | Natick, MA | Rubble Pile | I |
| 800 | Natick, MA | Brick Building | II |
| 825 | Fall River, MA | Concrete Rubble Pile | I |
| 830 | Fall River, MA | Concrete Rubble Pile | I |
| 835 | Fall River, MA | Wood Rubble Pile | I |
| 840 | Fall River, MA | Brick Rubble Pile | I |
| 843 | Fall River, MA | Brick Rubble Pile | I |
| 845 | Fall River, MA | Rusty Metal Rubble Pile | I |
| 850 | Fall River, MA | Metal, Concrete and Wood Rubble Pile | I |

elements (pixels) in that scene together based on their color. These groups are called domains. The optimum number of domains needed to describe each scene was determined using the methodology developed by Natick in conjunction with Decilog, Inc. of Melville, NY[5]. This method uses the calculated ratio of the between domain variance to the within domain variance, called Beta 4. The critical value at which the domains account for 90% of the total variance is taken from a Table of Critical Values of F, at the 90% level with n-1 degrees of freedom, where n is the number of domains[6]. The minimum number of domains needed is determined by plotting the Beta 4 values as in Figure 1.

In Figure 1, the F values are illustrated by the squares, and the x's represent the Beta 4 values calculated for Scene 835. The crossover for the two curves occurs between 4 and 5 domains. The number of domains needed is the next higher integral number from the crossover, or in this case, five domains. Appendix A contains the Beta 4 values for each of the scenes, and Appendix B lists the optimum number of domains found for each scene using this method. Appendix B also contains the 1976 International Commission on Illumination (CIE) L*a*b* (CIELAB)[7] values (using $D_{65}$ and the 10 degree standard observer) and the percentage of the scene included by each domain. Appendix C contains the Munsell Notation for each domain, based on the CIELAB values contained in Appendix B, to give the reader an idea of the appearance of the

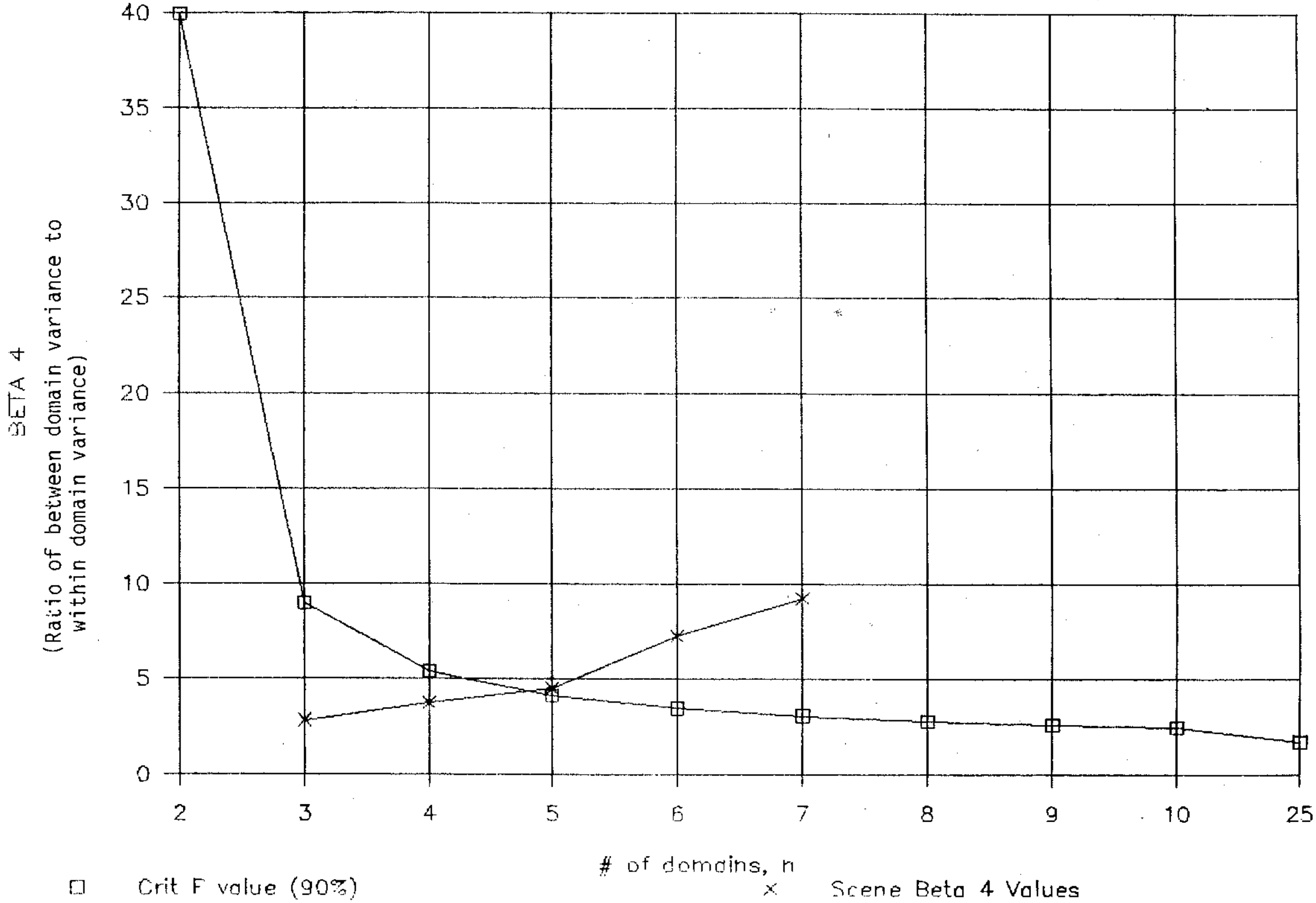


Figure 1. Plot of Beta 4 vs. Number of Domains to Determine the Optimum Number of Domains Needed to Describe Scene 835. (Domains = picture elements (pixels) grouped by color.)

colors represented by the CIELAB values[8]. Table 2 is a summary version of Appendix B. Tables 3 to 5 contain selected CIELAB values from Appendix B.

## Discussion

As indicated in Table 2, 4 to 8 domains are needed to define the various scenes. Type I has an average of 6.1 domains, and Type II is 5.5. In many cases, more domains are needed than the software can display (5 is the maximum). This is due to the large variability of building materials and colors that can be used in an urban environment, compared to the number of colors to be found in a typical woodland scene. In many of the scenes, the percentage of the scene occupied by a given domain is small (< 10%). In comparison, the smallest area of the Woodland camouflage pattern, Black 357, comprises 16% of the pattern.

As a measure of the variability of the colors in each scene, the mean color difference from the mean[9] (MCDM) was determined for the domains in each scene. The MCDM is calculated by determining the color difference for each

Table 2. Optimum Number of Domains Separated by Type

| Scene # | Type | # of Domains[a] | MCDM[b] |
|---|---|---|---|
| 705 | I (Rubble) | 8 | 10.13 |
| 795 | I | 5 | 12.29 |
| 825 | I | 7 | 11.22 |
| 830 | I | 4 | 14.66 |
| 835 | I | 5 | 15.64 |
| 840 | I | 6 | 9.54 |
| 843 | I | 7 | 10.93 |
| 845 | I | 7 | 12.25 |
| 850 | I | 6 | 10.95 |
| | AVERAGE | 6.1 | 11.96 |
| | STANDARD DEVIATION | 1.2 | 1.91 |
| 760 | II (Building) | 5 | 3.53 |
| 765 | II | 6 | 4.33 |
| 780 | II | 4 | 5.12 |
| 785 | II | 4 | 2.33 |
| 790 | II | 6 | 1.74 |
| 800 | II | 8 | 2.44 |
| | AVERAGE | 5.5 | 3.25 |
| | STANDARD DEVIATION | 1.4 | 1.19 |

[a] Picture elements (pixel) grouped by color
[b] Mean Color Difference from Mean

domain in the scene against the mean CIELAB values for all of the domains in the scene. These color differences are then averaged and called the MCDM. They provide a measure of the variation in the scene and are reported in Table 2. The larger the MCDM, the larger the color difference is between the various colors in the scene. As a point of reference, the MCDM for the standard Woodland pattern colors is 10.50. When the color differences for textile acceptability of 16 monotone shades and their limit samples were examined, the average color difference from the standard ranged from 0.32 to 2.46[10]. The Type II scenes show much less variation in color than the Type I scenes, asexpected for the more uniform building facades. Although a large number of domains are necessary to describe these scenes (4 to 8 domains), the color differences between the various domains is small. The MCDM's for the Type I scenes are much larger and of the same order of magnitude as the Woodland pattern.

Figure 2 is an a* vs. b* plot of all of the domains, and Figure 3 is an L* vs. b* plot. L* is a measure of lightness, a* is a measure of the redness (positive axis) or greenness (negative axis), and b* is a measure of the yellowness (positive axis) or blueness (negative axis). The minimum, maximum, average and weighted average (by percentage of total pixels assigned) CIELAB values for all of the domains are listed in Table 3. Figures 4 to 7 and Tables 4 to 5 contain similar information for the domains separated by scene type (I or II). The Type I scenes vary over almost the entire lightness gamut (an L* of 0.0 corresponds to black and 100.0 to white) and the Type II scenes over a slightly smaller range. Most of the points for both types fall within the red, orange, yellow and neutral regions of color space.

Table 3. Selected CIELAB Values for All Urban Scenes.

| | L* [a] | a* [b] | b* [c] |
|---|---|---|---|
| Minimum | 8.04 | -7.04 | -8.87 |
| Maximum | 95.81 | 22.63 | 41.03 |
| Average | 52.28 | 5.93 | 15.14 |
| Weighted Average | 50.42 | 6.54 | 14.15 |

[a] L* = Lightness (0 = black, 100 = white)
[b] a* = Redness (positive) or greenness (negative)
[c] b* = Yellowness (positive) or blueness (negative)

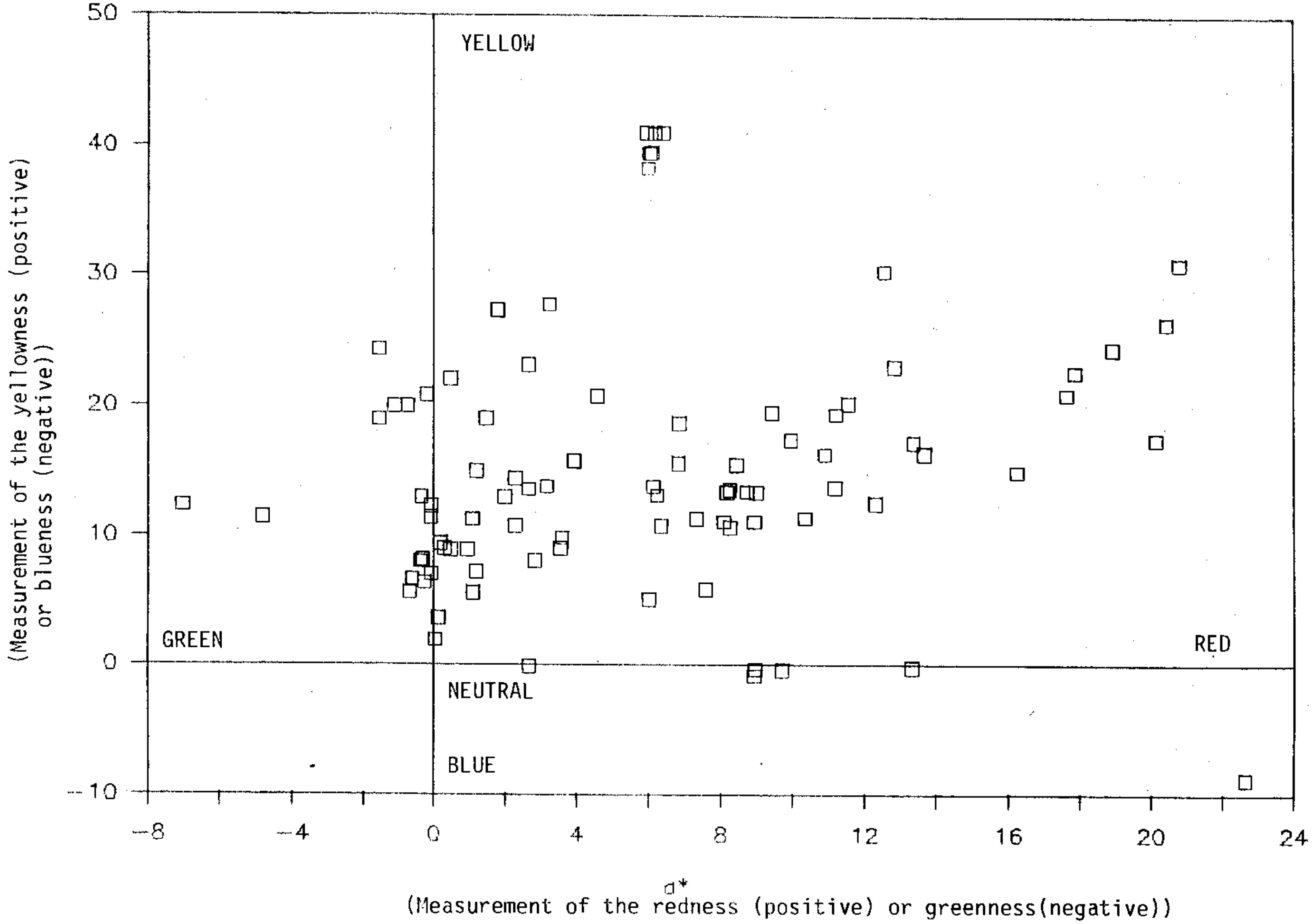


Figure 2. Plot of a* (redness/greenness) vs. b* (yellowness/blueness) of the Domains for All of the Urban Scenes. (Domains = picture elements (pixels) grouped by color.)

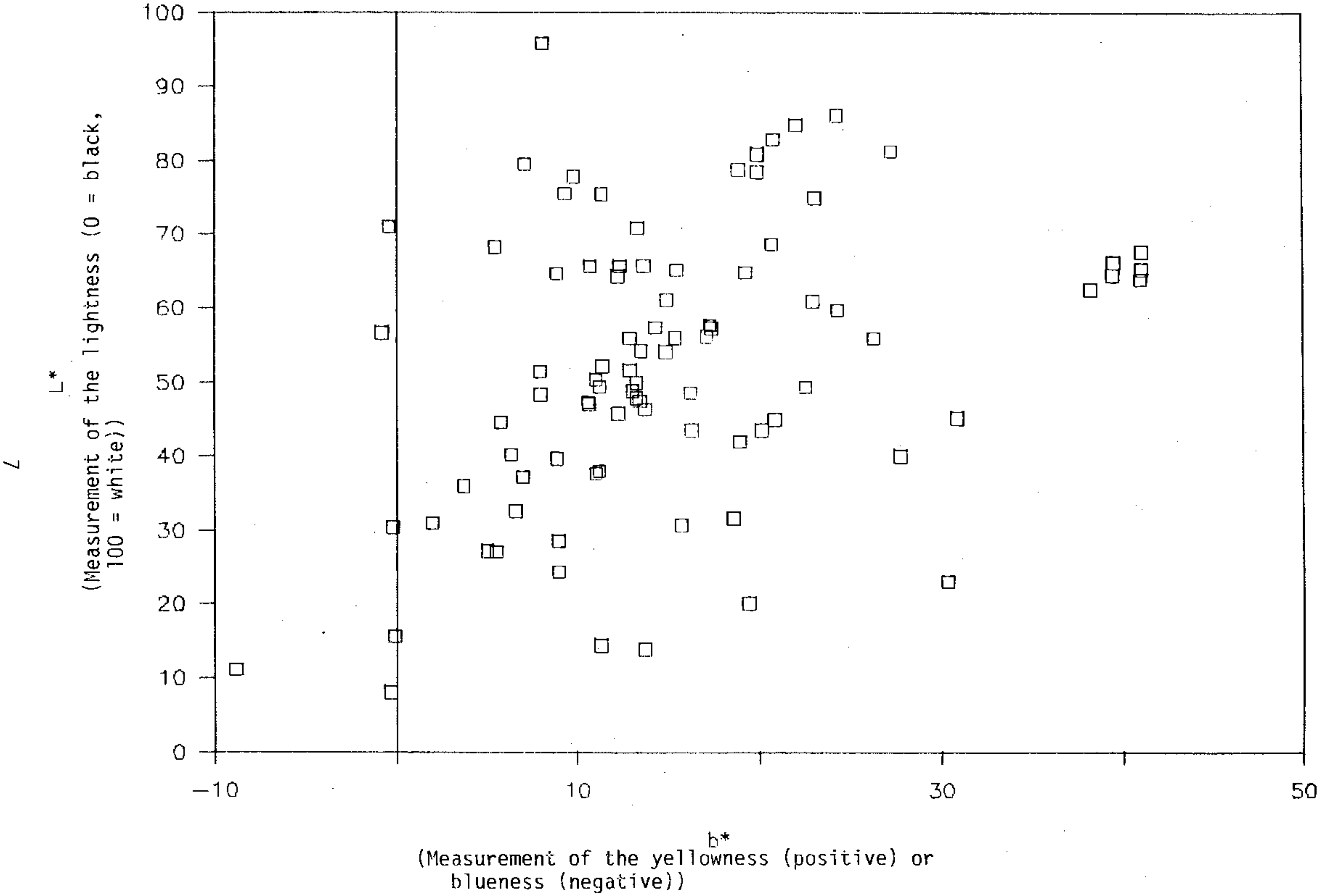


Figure 3. Plot of b* (yellowness/blueness) vs. L* (lightness) of the Domains for All of the Urban Scenes. (Domains = picture elements (pixels) grouped by color.)

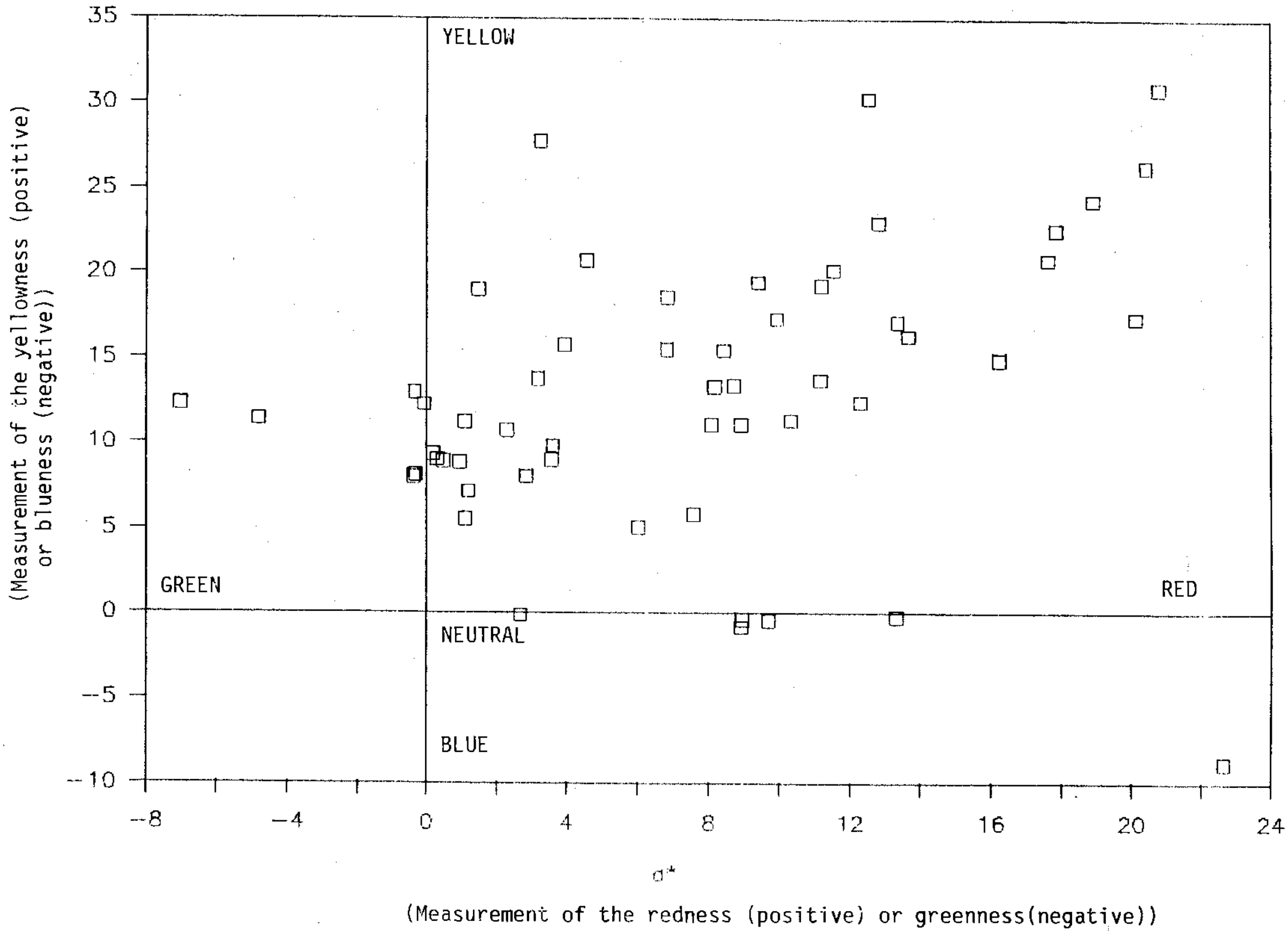


Figure 4. Plot of a* (redness/greenness) vs. b* (yellowness/blueness) of the Domains for the Type I Urban Scenes. (Domains = picture elements (pixels) grouped by color.)

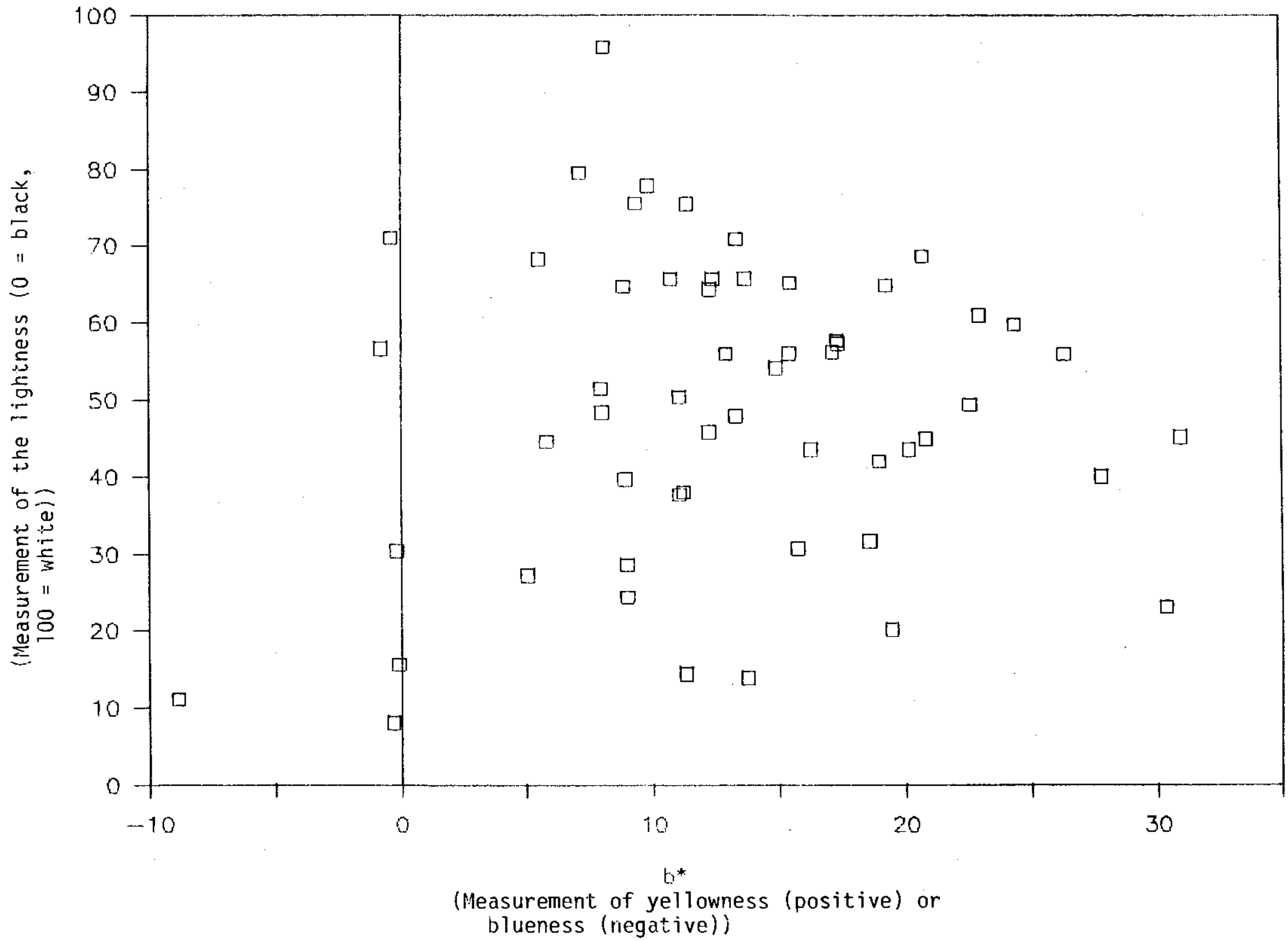


Figure 5. Plot of b* (yellowness/blueness) vs. L* (lightness) of the Domains for the Type I Urban Scenes. (Domains = picture elements (pixels) grouped by color.)

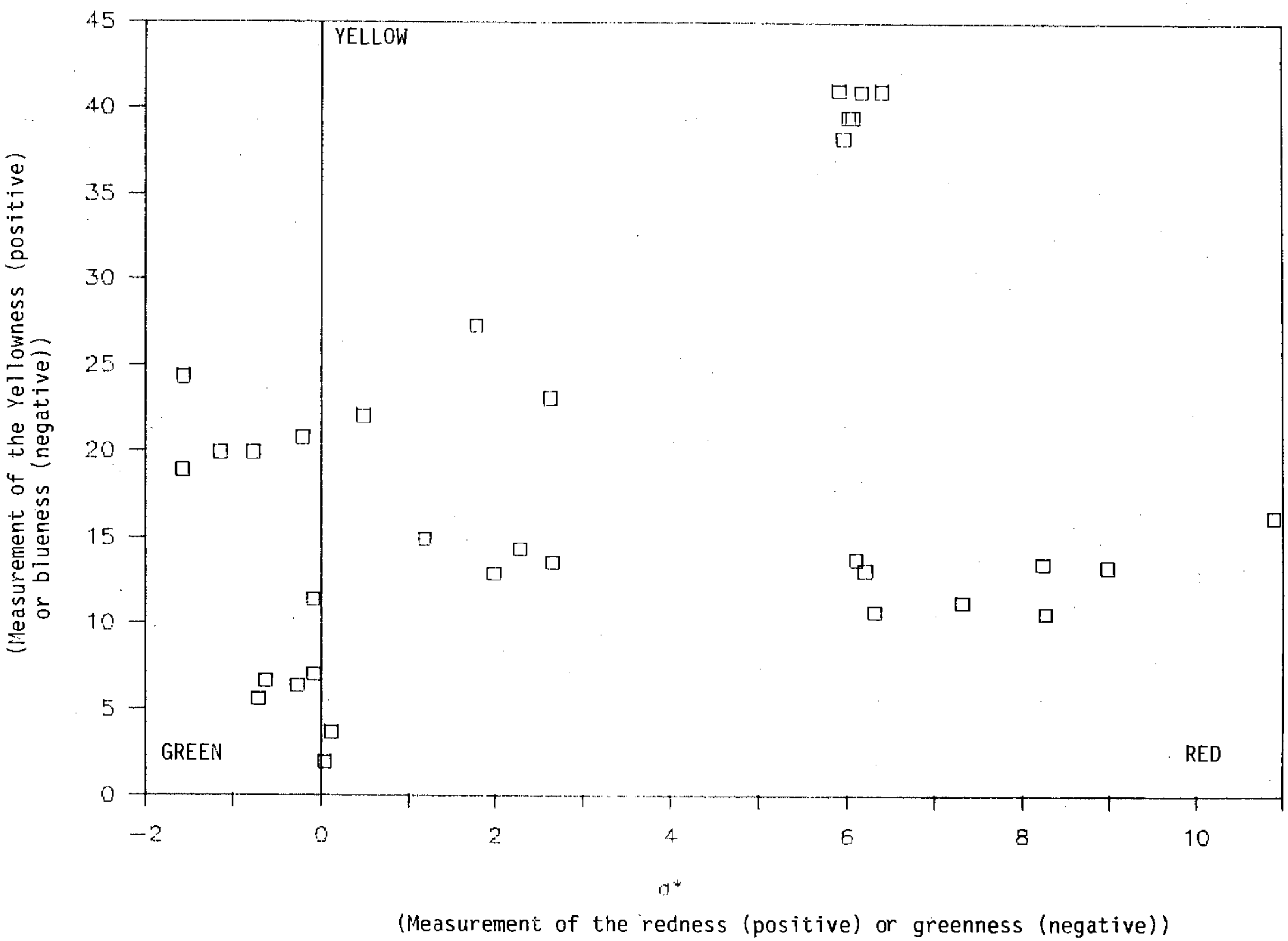


Figure 6. Plot of a* (redness/greenness) vs. b* (yellowness/blueness) of the Domains for the Type II Urban Scenes. (Domains = picture elements (pixels) grouped by color.)

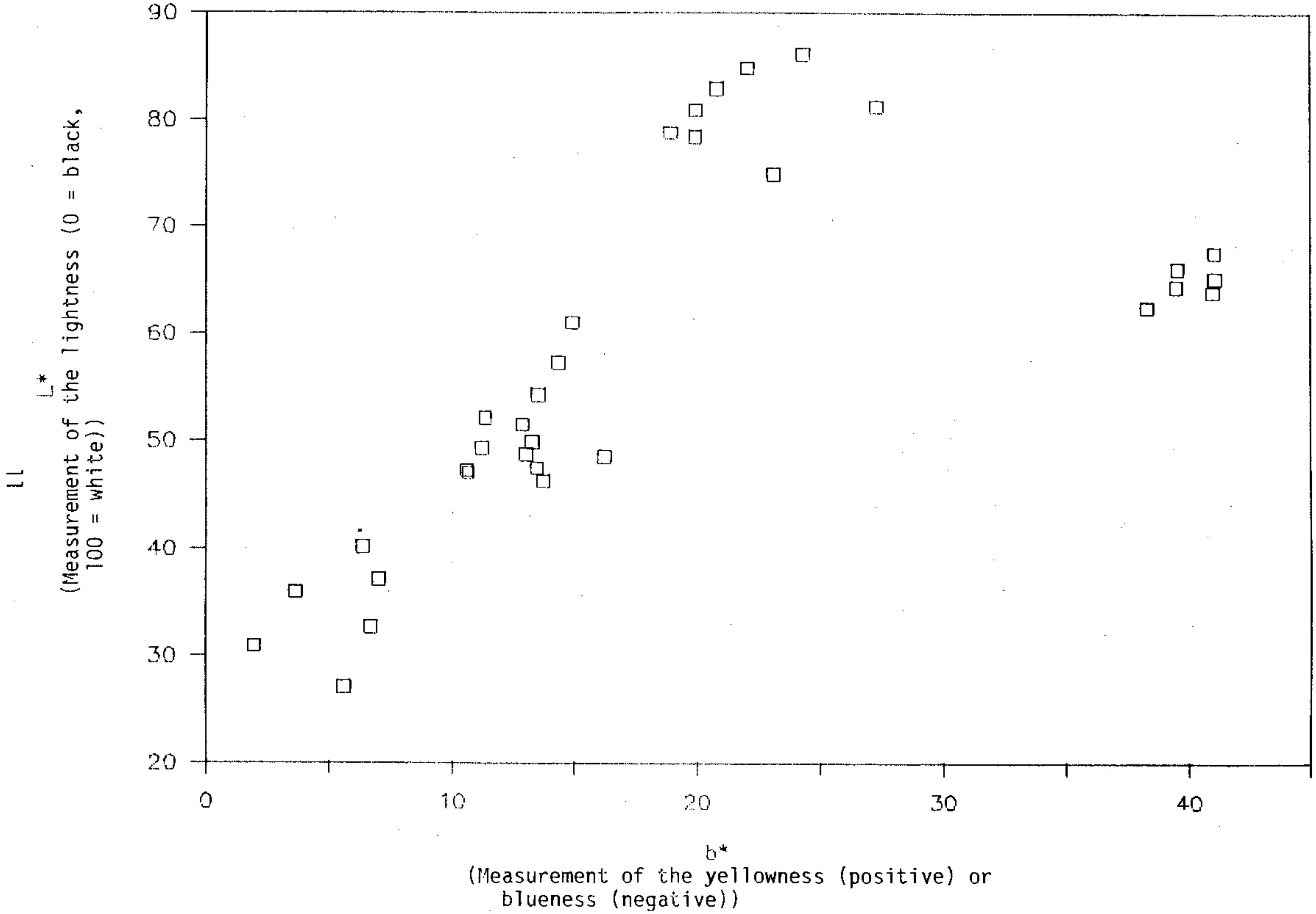


Figure 7. Plot of b* (yellowness/blueness) vs. L* (lightness) of the Domains for the Type II Urban Scenes. (Domains = picture elements (pixels) grouped by color.)

Table 4. Selected CIELAB Values for Type I Urban Scenes.

| | L*[a] | a*[b] | b*[c] |
|---|---|---|---|
| Minimum | 8.04 | -7.04 | -8.87 |
| Maximum | 95.81 | 22.63 | 30.90 |
| Average | 49.06 | 7.57 | 13.00 |
| Weighted Average | 46.99 | 8.12 | 12.14 |

[a] L* = Lightness (0 = black, 100 = white)
[b] a* = Redness (positve) or greenness (negative)
[c] b* = Yellowness (positive) or blueness (negative)

Table 5. Selected CIELAB Values for Type II Urban Scenes.

| | L*[a] | a*[b] | b*[c] |
|---|---|---|---|
| Minimum | 27.06 | -1.58 | 1.93 |
| Maximum | 86.11 | 10.89 | 41.03 |
| Average | 57.64 | 3.18 | 18.70 |
| Weighted Average | 59.10 | 2.51 | 19.25 |

[a] L* = Lightness (0 = black, 100 = white)
[b] a* = Redness (positve) or greenness (negative)
[c] b* = Yellowness (positive) or blueness (negative)

## Conclusions

The collected terrain data, along with other data, were used in the development of candidate urban camouflage patterns. The elements of a camouflage pattern must be discernible to be effective[11]. If the various elements of the pattern are too small (<10% of the pattern) or too close in color to other elements in the pattern (< approximately 2.5 CIELAB units), the pattern will quickly merge to a monotone. While 4 to 8 domains may be necessary to define the background scene, a smaller number of domains may be acceptable to define an effective camouflage pattern for use in that type of scene.

An additional factor to be considered in determining the number of colors to use in a camouflage print is the number of colors that can be readily controlled by industry in a production environment. For each shade in a pattern, a standard and color tolerance must be established and maintained for procurement purposes. Also, many shades require infrared spectral tolerances, so the various camouflage elements in the pattern must be large enough to be measured spectrophotometrically (greater than approximately 1" in diameter). A

compromise must be reached between the number of colors necessary for effective camouflage and what can be produced by industry in quantity and at a reasonable cost. Another requirement is for a single pattern that can be used in both the Type I and Type II terrains.

While the Terrain Analysis System can help to identify colors and patterns for use in a particular type of terrain, a human observer must still make the final judgement as to how many colors will provide a good representation for camouflage purposes. The terrain data can then be clustered to the number of domains desired and a pattern produced for further testing.

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## Appendix A - Beta 4 Values for the Scenes

| Domains, n | $F_{0.90}$ | Scene # 705 | 760 | 765 | 780 | 785 |
|---|---|---|---|---|---|---|
| 2 | 39.90 | | 2.17o | 2.12o | | 3.91o |
| 3 | 9.00 | 1.39o | 2.77o | 2.61o | 4.46o | 6.60o |
| 4 | 5.39 | 1.90o | 4.31o | 2.95o | 5.57o | 8.12o |
| 5 | 4.11 | 2.24o | 5.28o | 3.55o | 7.82o | 9.71o |
| 6 | 3.45 | 2.47o | | 4.86o | | |
| 7 | 3.05 | 2.99o | | 9.53x | | |
| 8 | 2.78 | 3.26o | | 9.32x | | |
| 9 | 2.59 | | | | | |
| 10 | 2.44 | | | | | |

| Domains, n | $F_{0.90}$ | Scene # 790 | 795 | 800 | 825 | 830 |
|---|---|---|---|---|---|---|
| 2 | 39.90 | 1.64o | 1.31o | 0.87o | 1.71o | 2.68o |
| 3 | 9.00 | 2.12o | 2.46o | 1.66o | 2.02o | 5.50o |
| 4 | 5.39 | 3.06o | 4.19o | 2.13o | 2.35o | 12.03o |
| 5 | 4.11 | 3.72o | 4.93o | 2.42o | 3.03o | |
| 6 | 3.45 | 4.90o | 6.85x | 2.44o | 3.37o | |
| 7 | 3.05 | 10.92x | 6.22x | 2.80o | 3.79o | |
| 8 | 2.78 | | | 2.99o | | |
| 9 | 2.59 | | | 3.64x | | |
| 10 | 2.44 | | | | | |

| Domains, n | $F_{0.90}$ | Scene # 835 | 840 | 843 | 845 | 850 |
|---|---|---|---|---|---|---|
| 2 | 39.90 | | 1.71o | 1.42o | | |
| 3 | 9.00 | 2.80o | 2.50o | 1.63o | 1.80o | 2.51o |
| 4 | 5.39 | 3.72o | 3.02o | 2.29o | 2.16o | 3.52o |
| 5 | 4.11 | 4.52o | 3.78o | 2.72o | 2.82o | 3.93o |
| 6 | 3.45 | 7.26x | 4.32o | 3.22o | 3.39o | 4.25o |
| 7 | 3.05 | 9.24x | | 3.74o | 3.71o | 7.98x |
| 8 | 2.78 | | | 4.92x | 5.96x | 9.27x |
| 9 | 2.59 | | | | | |
| 10 | 2.44 | | | | | |

**NOTE: o denotes values of Beta 4 after optimization, x denotes values without optimization.

Appendix B - Optimum Number of Domains for each Scene

| Scene # | Domains, n | L* | a* | b* | % of scene |
|---|---|---|---|---|---|
| 705 | 8 | 43.41 | 11.55 | 20.15 | 7.0 |
| | | 45.67 | -0.07 | 12.26 | 7.7 |
| | | 50.30 | 8.91 | 11.06 | 10.8 |
| | | 65.62 | 2.28 | 10.74 | 12.0 |
| | | 65.65 | 11.18 | 13.68 | 20.3 |
| | | 57.59 | 9.94 | 17.31 | 19.2 |
| | | 57.27 | 20.10 | 17.37 | 11.2 |
| | | 55.82 | -0.37 | 12.92 | 11.8 |
| 760 | 5 | 52.13 | -0.09 | 11.41 | 19.2 |
| | | 61.01 | 1.19 | 14.92 | 6.4 |
| | | 57.30 | 2.28 | 14.35 | 17.6 |
| | | 54.23 | 2.65 | 13.56 | 29.7 |
| | | 51.50 | 1.98 | 12.91 | 27.1 |
| 765 | 6 | 40.15 | -0.27 | 6.36 | 11.9 |
| | | 30.90 | 0.04 | 1.93 | 11.0 |
| | | 35.96 | 0.12 | 3.63 | 22.1 |
| | | 37.13 | -0.08 | 7.01 | 26.4 |
| | | 32.61 | -0.64 | 6.66 | 18.3 |
| | | 27.06 | -0.72 | 5.57 | 10.3 |
| 780 | 4 | 74.92 | 2.63 | 23.08 | 5.0 |
| | | 81.24 | 1.79 | 27.27 | 5.0 |
| | | 86.11 | -1.57 | 24.29 | 84.3 |
| | | 78.40 | -1.15 | 19.91 | 5.7 |
| 785 | 4 | 82.87 | -0.21 | 20.79 | 25.8 |
| | | 84.80 | 0.48 | 22.03 | 28.2 |
| | | 80.90 | -0.78 | 19.92 | 27.5 |
| | | 78.78 | -1.58 | 18.91 | 18.5 |
| 790 | 6 | 66.10 | 6.08 | 39.50 | 19.5 |
| | | 64.39 | 6.03 | 39.46 | 13.3 |
| | | 63.87 | 6.18 | 40.95 | 16.4 |
| | | 67.63 | 6.41 | 41.00 | 22.3 |
| | | 65.18 | 5.93 | 41.03 | 26.6 |
| | | 62.48 | 5.98 | 38.26 | 1.9 |
| 795 | 5 | 37.66 | 8.07 | 11.07 | 8.0 |
| | | 65.11 | 6.82 | 15.47 | 25.9 |
| | | 77.79 | 3.58 | 9.83 | 11.7 |
| | | 55.91 | 8.42 | 15.40 | 31.6 |
| | | 47.79 | 8.17 | 13.29 | 22.9 |
| 800 | 8 | 47.43 | 8.23 | 13.48 | 12.5 |
| | | 49.88 | 8.97 | 13.29 | 9.4 |
| | | 46.24 | 6.11 | 13.74 | 12.9 |
| | | 47.01 | 6.32 | 10.68 | 12.6 |
| | | 47.27 | 8.26 | 10.62 | 13.3 |
| | | 48.75 | 6.21 | 13.07 | 15.4 |
| | | 48.53 | 10.89 | 16.21 | 4.5 |
| | | 49.34 | 7.31 | 11.26 | 19.4 |

Appendix B (continued) - Optimum Number of Domains for each Scene

| Scene # | Domains, n | L* | a* | b* | % of scene |
|---|---|---|---|---|---|
| 825 | 7 | 64.23 | -7.04 | 12.30 | 10.6 |
| | | 75.46 | -4.83 | 11.39 | 14.7 |
| | | 56.58 | 8.92 | -0.82 | 8.9 |
| | | 68.20 | 1.10 | 5.53 | 20.3 |
| | | 71.09 | 9.68 | -0.42 | 12.5 |
| | | 51.43 | -0.38 | 7.97 | 10.0 |
| | | 79.47 | 1.18 | 7.17 | 23.0 |
| 830 | 4 | 75.49 | 0.20 | 9.36 | 22.1 |
| | | 95.81 | -0.34 | 8.12 | 1.8 |
| | | 64.64 | 0.93 | 8.87 | 40.4 |
| | | 48.28 | 2.80 | 8.02 | 35.7 |
| 835 | 5 | 30.41 | 13.32 | -0.21 | 21.2 |
| | | 11.10 | 22.63 | -8.87 | 11.5 |
| | | 28.53 | 0.29 | 9.00 | 18.5 |
| | | 8.04 | 8.93 | -0.35 | 16.8 |
| | | 44.49 | 7.57 | 5.82 | 32.0 |
| 840 | 6 | 49.26 | 17.84 | 22.57 | 11.6 |
| | | 70.92 | 8.71 | 13.35 | 12.0 |
| | | 56.06 | 13.35 | 17.13 | 19.6 |
| | | 43.49 | 13.66 | 16.28 | 9.4 |
| | | 59.64 | 18.88 | 24.34 | 13.1 |
| | | 64.77 | 11.20 | 19.28 | 34.3 |
| 843 | 7 | 45.06 | 20.76 | 30.90 | 11.2 |
| | | 60.89 | 12.82 | 22.96 | 16.5 |
| | | 65.60 | 12.31 | 12.40 | 9.1 |
| | | 68.66 | 4.55 | 20.72 | 8.1 |
| | | 44.92 | 17.61 | 20.83 | 16.7 |
| | | 54.02 | 16.22 | 14.87 | 16.0 |
| | | 55.86 | 20.41 | 26.30 | 22.4 |
| 845 | 7 | 23.08 | 12.54 | 30.31 | 10.6 |
| | | 14.40 | 10.34 | 11.33 | 9.6 |
| | | 37.96 | 1.07 | 11.22 | 11.1 |
| | | 15.56 | 2.66 | -0.12 | 9.8 |
| | | 31.62 | 6.83 | 18.58 | 15.6 |
| | | 20.11 | 9.40 | 19.45 | 13.7 |
| | | 27.20 | 6.01 | 5.04 | 29.6 |
| 850 | 6 | 39.67 | 0.47 | 8.91 | 9.8 |
| | | 41.96 | 1.46 | 18.97 | 8.5 |
| | | 13.86 | 3.15 | 13.73 | 15.6 |
| | | 30.66 | 3.91 | 15.73 | 24.7 |
| | | 39.97 | 3.24 | 27.74 | 10.3 |
| | | 24.39 | 3.54 | 8.99 | 31.0 |

## Appendix C - Munsell Color Notations for Scenes

| Scene # | Domain | Munsell Notation |
|---|---|---|
| 705 | 1 | 6.56YR 4.21/3.70 |
| | 2 | 4.68Y 4.43/1.75 |
| | 3 | 4.03YR 4.88/2.48 |
| | 4 | 0.53Y 6.39/1.68 |
| | 5 | 3.10YR 6.40/3.24 |
| | 6 | 6.03YR 5.59/3.40 |
| | 7 | 0.13YR 5.56/4.99 |
| | 8 | 4.57Y 5.42/1.83 |
| 760 | 1 | 4.40Y 5.05/1.66 |
| | 2 | 2.90Y 5.93/2.16 |
| | 3 | 1.89Y 5.56/2.16 |
| | 4 | 1.49Y 5.26/2.09 |
| | 5 | 2.15Y 4.99/1.96 |
| 765 | 1 | 5.61Y 3.90/0.93 |
| | 2 | 4.98Y 3.01/0.34 |
| | 3 | 4.52Y 3.50/0.57 |
| | 4 | 5.09Y 3.61/1.05 |
| | 5 | 6.84Y 3.18/1.04 |
| | 6 | 7.50Y 2.64/0.93 |
| 780 | 1 | 1.98Y 7.34/3.42 |
| | 2 | 2.42Y 7.99/3.99 |
| | 3 | 4.46Y 8.49/3.26 |
| | 4 | 4.59Y 7.70/2.73 |
| 785 | 1 | 3.64Y 8.16/2.87 |
| | 2 | 5.06BG 8.36/14.04 |
| | 3 | 4.17Y 7.95/2.74 |
| | 4 | 5.03Y 7.74/2.56 |
| 790 | 1 | 1.86Y 6.44/5.93 |
| | 2 | 1.87Y 6.30/5.91 |
| | 3 | 1.92Y 6.22/6.11 |
| | 4 | 1.80Y 6.60/6.17 |
| | 5 | 2.04Y 6.35/6.12 |
| | 6 | 1.82Y 6.08/5.72 |
| 795 | 1 | 5.52YR 3.66/2.18 |
| | 2 | 7.84YR 6.34/2.78 |
| | 3 | 7.99YR 7.63/1.76 |
| | 4 | 6.71YR 5.43/2.95 |
| | 5 | 6.33YR 4.63/2.57 |
| 800 | 1 | 6.37YR 4.60/2.59 |
| | 2 | 5.32YR 4.84/2.72 |
| | 3 | 8.66YR 4.48/2.35 |
| | 4 | 6.70YR 4.56/2.03 |
| | 5 | 4.42YR 4.58/2.28 |
| | 6 | 8.06YR 4.73/2.33 |
| | 7 | 5.12YR 4.70/3.30 |
| | 8 | 5.85YR 4.78/2.26 |

Appendix C (continued) - Munsell Notations for Scenes

| Scene # | Domain | Munsell Notation |
|---|---|---|
| 825 | 1 | 5.01GY 6.25/1.93 |
| | 2 | 2.82GY 7.39/1.58 |
| | 3 | 5.61RP 5.49/2.21 |
| | 4 | 0.83Y 6.65/0.89 |
| | 5 | 6.17RP 6.95/2.62 |
| | 6 | 4.98Y 4.99/1.16 |
| | 7 | 0.65Y 7.81/1.13 |
| 830 | 1 | 2.92Y 7.40/1.33 |
| | 2 | 2.40YR 9.48/1.03 |
| | 3 | 2.10Y 6.30/1.32 |
| | 4 | 9.62YR 4.68/1.34 |
| 835 | 1 | 7.99RP 2.96/2.37 |
| | 2 | 6.55R 1.05/**** |
| | 3 | 4.75Y 2.78/1.45 |
| | 4 | 4.72GY 0.76/2.22 |
| | 5 | 0.76YR 4.31/1.71 |
| 840 | 1 | 3.56YR 4.78/4.96 |
| | 2 | 4.81YR 6.93/2.84 |
| | 3 | 3.63YR 5.44/3.86 |
| | 4 | 3.66YR 4.22/3.56 |
| | 5 | 3.27YR 5.80/5.46 |
| | 6 | 5.62YR 6.31/3.84 |
| 843 | 1 | 4.61YR 4.37/6.24 |
| | 2 | 6.10YR 5.92/4.45 |
| | 3 | 1.51YR 6.39/3.31 |
| | 4 | 0.47Y 6.70/3.24 |
| | 5 | 3.42YR 4.35/4.62 |
| | 6 | 1.01YR 5.24/4.06 |
| | 7 | 3.36YR 5.42/5.83 |
| 845 | 1 | 8.08YR 2.25/5.12 |
| | 2 | 5.65R 1.38/**** |
| | 3 | 3.36Y 3.69/1.66 |
| | 4 | 7.27BG 1.49/0.39 |
| | 5 | 9.82YR 3.08/3.17 |
| | 6 | 8.92YR 1.96/3.56 |
| | 7 | 2.82YR 2.66/1.30 |
| 850 | 1 | 4.00Y 3.85/1.30 |
| | 2 | 3.98Y 4.07/2.72 |
| | 3 | 7.46R 1.33/**** |
| | 4 | 1.72Y 2.99/2.58 |
| | 5 | 3.54Y 3.88/4.02 |
| | 6 | 10.00YR 2.38/1.61 |